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(71) Applicant(s)
Victaulic Plc

(Incorporated in the United Kingdom)

46-48 Wilbury Way, HITCHIN, Hertfordshire, SG4 0UD, United Kingdom

(72) Inventor(s)
David John Hill
Jennifer Ellen Cambers

(74) Agent and/or Address for Service
Fry Heath & Spence
The Old College, 53 High Street, HORLEY, Surrey, RH6 7BN, United Kingdom

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(54) Replacing pipeline and replacement pipe construction

(57) An existing pipeline is replaced by causing a pipe-bursting head to be moved through it so as to split it into pieces, a new pipeline being towed behind the bursting head; the new pipeline is formed from a length or lengths of pipe having a polyethylene main pipe body and an outer protective layer of polypropylene which has enhanced abrasion resistance, cut resistance and point impingement resistance relative to the polyethylene, and wherein the polypropylene layer is readily removable in at least the end regions of the pipe to enable the end regions to be coupled to other pipelines or pipe elements by mechanical and/or fusion means. The outer layer is not bonded, but, at the most, lightly adhered to the main pipe to enable the outer layer to be cut away at the pipe section ends to enable jointing of sections. Optionally, the outer layer incorporates toughening agents, e.g. mineral based, glass beads, hollow glass spheres.

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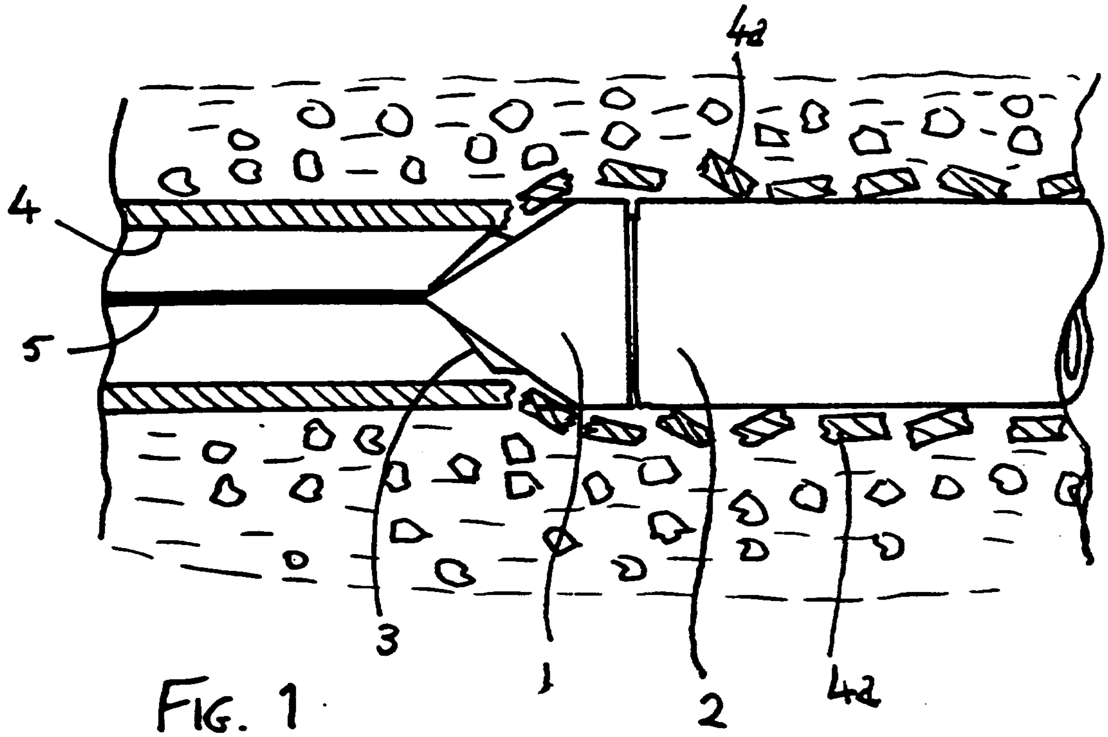

FIG. 1

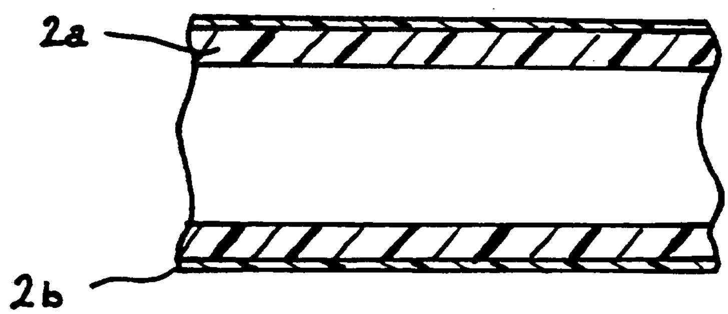

FIG. 2

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IMPROVEMENTS IN AND RELATING TO PIPELINE REPLACEMENT

The present invention relates to an improved method and apparatus for use in replacement of existing pipelines, and to an improved pipe for use in such applications.

In recent years pipe-bursting techniques have been developed for replacing existing worn out pipelines formed from, for example, cast iron, unplasticised PVC or clay. Such pipe-bursting techniques typically involve forcing a pipe-bursting head through an existing pipeline with the new pipeline, or a sacrificial sleeve, being hauled through the old pipeline by the bursting head. The bursting head splits apart the existing pipe wall to create room for the new pipeline or sacrificial sleeve.

A number of splitting methods are used, the most widely used being a pneumatic method which employs a vibrating head which batters into the old pipe thus splitting it. The cone-shaped bursting head, as it moves

through the old pipeline, pushes the shards of broken pipe outwards and the vibration results in a settling effect leaving the pipe pieces roughly arranged in a longitudinal direction.

An alternative pipe-bursting method involves a hydraulic system in which an expanding pipe-bursting head is drawn into the old pipeline and then expanded hydraulically to split the old pipe and push it outwards. The pipe-bursting head, followed by an expander which increases the pilot bore to take either the new pipe or sacrificial sleeve, is then pulled forward and expanded again and so on. A potential problem here is that there is a greater danger of the shards of broken pipe wall turning into the new pipe wall as the head is pulled forward each time.

It has been recognised that hauling a new polyolefin pipeline behind a pipe-bursting head can lead to damage to the pipe as a result of cuts by the shards of old pipeline material, or through other sharp-edged objects such as stones in the vicinity of the pipe. Where the pipe wall is relatively thick, cuts and gouges in the outer surface of the new pipeline can be tolerated provided that they do not go to a depth of more than about 10% of the wall thickness. However, for pipes of lesser wall thickness, where a deep gouge or cut could substantially weaken the pipeline, it is considered undesirable to haul such pipes directly behind

a pipe-bursting head. With such pipes, it has become conventional to haul a sacrificial sleeve behind the pipe-bursting head and then, once the sleeve is in position, insert the new pipeline through the sleeve by means of slip-lining.

One problem with the use of a sacrificial polyethylene sleeve is that it is considered generally to add around 40% to the material costs of a pipe-bursting project and around 5% to the contracting costs. The contracting or labour costs include the need to butt-fuse the ends of successive lengths of liner sleeve together and the time taken for the additional slip-lining operation. A further problem is that it has been found that making service connections from such pipelines is greatly complicated by having to break through an outer protective sleeve and there have been occasions where a brand new pipe has been damaged as a result of this operation.

In addition, unless an oversized mole or pipe-bursting head is used to create room for a sacrificial sleeve of greater outer diameter than the original pipeline, the bore of the new pipe slip-lined into the sacrificial sleeve will almost inevitably be less than that of the original pipeline, therefore leading to a reduction in capacity of the pipeline.

Thus, at the present time, there remains a need for a

process for replacing existing pipelines using a pipe-bursting technique in which a length of replacement pipeline can be towed directly behind the bursting head but is nevertheless adequately protected against mechanical damage by sharp edges such as the old pipe fragments in the surrounding ground.

The present invention sets out to meet the above mentioned need and seeks to do this by providing an improved pipe for towing through behind a pipe-bursting head, the improved pipe having an outer coating of a material which has increased abrasion resistance relative to the main body of the pipe but which can be readily removed from the pipe in the vicinity of the ends in order to allow successive lengths of pipe to be connected together by, for example, electrofusion welding.

Accordingly, in a first aspect, the invention provides a method of replacing an existing pipeline by causing a pipe-bursting head to be moved through an existing pipeline so as to split the existing pipeline, a new pipeline being towed behind the bursting head; characterised in that the new pipeline is formed from a length or lengths of pipe having a polyethylene main pipe body and an outer protective layer of polypropylene which has enhanced abrasion resistance, cut resistance and point impingement resistance relative to the polyethylene, and wherein the polypropylene layer is readily removable in at least the

end regions of the pipeline to enable the end regions of the pipelines to be coupled to other pipelines or pipe elements by mechanical and/or fusion means.

In addition to being readily removable in the end regions of the pipeline, the polypropylene layer is preferably easily removable at any point between the ends to allow for the making of a service connection at the said point.

The polypropylene layer may have enhanced abrasion resistance, cut resistance and point impingement resistance by virtue of containing up to about 15% by weight (eg up to 10%) of a toughening agent. However, this is not essential since the polypropylene has been found to have good cut resistance and abrasion resistance without the toughening agent.

Where a toughening agent is included, the quantity of toughening agent will more typically be up to 8% by volume of the total volume of the coating layer, and more preferably will be up to about 5% of the coating layer. Examples of toughening materials include mineral-based materials, or glass beads, or hollow glass spheres.

The outer protective layer of polypropylene should not be bonded to the main body of the pipe and it is therefore preferred that the outer protective layer be applied after

the main body of the pipe has been formed and after cooling of the main body of the pipe. Thus, the main body of the pipe may be formed in conventional manner from medium density polyethylene (MDPE), high density polyethylene (HDPE), low density polyethylene (LDPE) or linear low density polyethylene (LLDPE) by means of extrusion. For example, a single-screw extruder may be connected to a pipe die from which the continuous annular melt emerges to be calibrated and cooled using the usual vacuum calibration method and spray cooling followed by ultrasonic gauging. Once calibrated, the pipe may be marked in the usual way, by hot-foil stamping or other convenient methods, to show the pipe dimensions, performance specification, manufacturing code etc. Under normal manufacturing conditions, the calibrated cooled and marked pipe would normally pass through a cutting machine either to be coiled and packed, or cut into convenient lengths and then packed. However, in accordance with the present invention, following marking the pipe passes through a further extrusion head (e.g. a cross-head die) so that the outer abrasion resistant coating layer may be applied. The coated pipe is then further cooled, marked in the usual way with suitable identifying marks and then coiled and packed, or cut into convenient lengths and packed.

Although the outer protective layer is not bonded to the main pipe, it may be lightly adhered to the main pipe, provided that it is still easily removable as defined

above. Thus, it may for example be lightly adhered to the main pipe by means of an adhesive type component in either the pipe or the protective layer, and preferably the protective layer. Alternatively, the surface of the pipe may be treated, prior to coating, e.g. by flame washing or corona discharge so as to render the surface of the polyethylene pipe more readily adherent to the coating.

In a further aspect, the invention provides a pipe having a main body formed from a polyolefin and an outer protective layer formed from polypropylene which has enhanced abrasion resistance, cut resistance and point impingement resistance relative to the polyethylene, the outer protective layer not being bonded to the main polyolefin body and being removable therefrom at least in the end regions of the pipe to enable the pipe to be coupled by mechanical or fusion methods.

The protective layer of polypropylene may optionally contain a toughening agent as defined hereinabove, which toughening agent may constitute up to 15% by volume (e.g. up to 10%) of the said layer.

By means of the method of the present invention, it is possible to replace an existing pipeline by means of a pipe bursting method in which the new pipe is towed directly behind the mole or pipe bursting head without fear of the polyethylene pipe wall being damaged by residual fragments

of fractured pipe and/or other sharp objects in the surrounding soil. A further advantage is that by towing a new pipe directly behind the pipe bursting head or mole, the extent of ground (soil) compression is less than would be encountered if a sacrificial liner were to be used. This has the advantage of minimising the effects on other utilities in the vicinity by reducing the amount of ground movement around the existing pipe during the pipe-bursting process. Less initial stress on the surrounding soil will also result in less relaxation stress on the pipe (or liner) wall and consequently long term damage to the new pipe by the surrounding shards of fractured original pipe is minimised.

The invention will now be illustrated by reference to the accompanying drawings of which:

Figure 1 is a schematic view showing a pipe-bursting head disrupting an existing pipeline and towing a new pipeline through the disrupted old pipeline; and

Figure 2 is a sectional elevation through part of the new pipeline shown in Figure 1.

Referring to the drawings, in the process of the invention, a pipe-bursting head 1 has attached to the rear end thereof a new pipeline 2, the construction of which is illustrated in more detail in Figure 2.

The bursting head shown in Figure 1 is of the expanding head variety and is provided with cutting edges 3 which are expanded radially outwardly to fracture the wall of the old existing pipeline 4 which may be a cast-iron pipeline. The bursting head 1 is towed through the old pipeline 4 by means of a winch and cable system shown schematically and identified by the numeral 5. Bursting head 1 operates by means of a hydraulic mechanism (not shown). Such hydraulic mechanisms are well known and do not need to be described here.

Instead of a hydraulic bursting head, a pneumatic bursting head could be used. The pneumatic bursting head would be forced through the old pipeline by means of a winch and cable system similar to that described above but would also be provided with a supply of compressed air which would be fed by a hole in through the new pipe 2 to the rear of the bursting head 1. Such pneumatically driven bursting heads typically have a vibrating head which batters the old pipe causing it to split.

As the old pipeline is split by the bursting head 1, fragments 4a of old pipeline material are created. When an expanding bursting head of the type shown in Figure 1 is employed, the fragments of old pipeline, e.g. cast-iron fragments, are often displaced by soil relaxation after passage of the mole and expander such that they present inwardly facing sharp edges which dig into and cut or gouge

the outer surface of the new pipeline 2.

However, in the process of the invention, the new pipeline is formed from a length or lengths of polyethylene pipe 2a coated with an outer layer 2b of a polypropylene material optionally incorporating toughening agents such as glass spheres. In the particular embodiment shown, the glass spheres make up about 5% of the volume of the layer 2b. However, greater or lesser concentrations of glass spheres or other toughening agents may be used as required, or the toughening agents may be omitted altogether for certain grades of polypropylene. Although the outer layer 2b may be cut or gouged by sharp edges in the ground, the inner main pipe body 2a is protected from damage during the installation process.

In order to allow the outer layer to be removed at the pipe ends, so that the pipe 2a can be coupled (e.g. by mechanical or fusion methods to another pipe) the outer layer 2b is not bonded to the pipe wall 2a. Instead it is applied after formation of the pipe 2a in a separate extruding process as described above. A further advantage of not bonding the outer layer 2b to the pipe wall 2a is that this removes any tendency for cracks or splits in the outer layer 2b to propagate through the pipe wall 2a.

The methods of extruding the pipe and subsequently applying the outer layer 2b from a cross-head die may be

entirely conventional and do not need to be described in detail here.

Example 1

A 50 mm SDR11 blue MDPE pipe (see British Standard BS6572) was extruded, vacuum calibrated, cooled and stamped in the usual manner. In line with these operations the pipe was paused through a cross head die and a layer of 1 mm thickness extrusion grade polypropylene copolymer was applied to the outside surface of the pipe. The coated pipe was further spray cooled, identification marks were applied and the pipe was then coiled in the usual manner.

EXAMPLE 2

A 90 mm nominal OD SDR 17.6 polyethylene pipe was extruded in a conventional manner using a Battenfeld single screw extruder and vacuum calibrator. The polymer composition used was a dark blue polyethylene PE 100 compound sold by BP Chemicals Limited under the name Rigidex PC3100. After extrusion, the pipe was passed through a vacuum calibration/spray cooling tank, and then through an ultrasonic thickness gauging device, followed by a further spray cooling tank, before marking in a conventional manner using a hot foil stamping machine. Immediately following marking, the pipe was passed through

an annular die which applied an external coating of natural polypropylene, of approximately 1mm thickness, from a 32mm Stork single screw extruder. The polypropylene used was a composition sold by Solvay Chemicals S.A. under the name Eltex-P RF110, to which had been added 1.5% of a UV stabiliser (Ampacet 40559-A supplied by Ampacet Europe S.A.) Following the external application of the polypropylene layer, the coated pipe was air cooled (as an alternative it could be water cooled) by passing through a further spray cooling tank dry. The pipe was then passed through a haul-off machine prior to final ink jet marking for identification purposes, and coiling and strapping. The pipe was cut using a swarfless saw, although a planetary saw blade can also be used. The pipe coating was measured and was found to vary between 0.8mm and 1.2mm in thickness. Although the coating was a tight fit on the base coat and could not be separated unaided by hand, it was found to be easily removable following slitting of the coating with a sharp blade.

As an alternative to using unpigmented polypropylene of the type referred to above, an opaque polypropylene coating can be formed by using a pigmented composition. As a further modification, an adhesive type component may be added to the polypropylene to give a slight tack to the polyethylene pipe surface, thereby increasing the resistance of the two layers to separation. In a further alternative, the base polyethylene pipe can be subjected to

flame washing or corona discharge immediately prior to coating in order to render the polyethylene surface more readily adherent to the polypropylene coating.

It will readily be appreciated that numerous modifications and alterations may be made to the embodiments shown in Figures 1 and 2 without departing from the principles underlying this invention. All such modifications and alterations are intended to be embraced by this Application.

CLAIMS

1. A method of replacing an existing pipeline by causing a pipe-bursting head to be moved through an existing pipeline so as to split the existing pipeline, a new pipeline being towed behind the bursting head; characterised in that the new pipeline is formed from a length or lengths of pipe having a polyethylene main pipe body and an outer protective layer of polypropylene which has enhanced abrasion resistance, cut resistance and point impingement resistance relative to the polyethylene, and wherein the polypropylene layer is readily removable in at least the end regions of the pipeline to enable the end regions of the pipelines to be coupled to other pipelines or pipe elements by mechanical and/or fusion means.

2. A method according to claim 1 wherein, in addition to being readily removable in the end regions of the pipeline, the polypropylene layer is easily removable at any point between the ends to allow for the making of a service connection at the said point.

3. A method according to claim 1 or claim 2 wherein the length or lengths of pipe is or are formed by applying the outer protective layer of polypropylene after the

polyethylene main pipe body has been formed and after cooling of the said main pipe body.

4. A method according to any one of claims 1 to 3 wherein the maid body of the pipe is formed from medium density polyethylene, high density polyethylene, low density polyethylene or linear low density polyethylene by means of extrusion.

5. A method according to any one of the preceding claims wherein the polypropylene layer contains up to about 15% by weight of a toughening agent.

6. A method according to claim 5 wherein the quantity of toughening agent is up to about 5% of the coating layer.

7. A pipe having a main body formed from a polyolefin and an outer protective layer formed from polypropylene which has enhanced abrasion resistance, cut resistance and point impingement resistance relative to the polyethylene, the outer protective layer not being bonded to the main polyolefin body and being removable therefrom at least in the end regions of the pipe to enable the pipe to be coupled by mechanical or fusion methods.

8. A pipe according to claim 7 wherein the protective layer of polypropylene contains up to about 15% by volume of a toughening agent.

9. A method substantially as described herein with reference to accompanying drawings.

10. A pipe substantially as described herein with reference to the examples.

Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)**	Application number GB 9523853.1
Relevant Technical Fields (i) UK Cl (Ed.O) F2P PC25, PC26, PC27, PC29, PL2, PL9 (ii) Int Cl (Ed.6) F16L 1/00, 1/024, 1/028, 1/032, 1/036, 1/038, 9/12, 9/133, 11/00, 11/04, 11/14	Search Examiner R BINDING Date of completion of Search 6 FEBRUARY 1996
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-10

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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P: Document published on or after the declared priority date but before the filing date of the present application.

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&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
Y	GB 2124325 A	(BRITISH GAS) see page 1 line 96 to page 2 line 24 and page 4 lines 89 to 92	1, 2, 4, 7
Y	GB 2092701 A	(BRITISH GAS) see page 1 lines 26 to 38, page 2 lines 41 to 98 and page 5 lines 35 to 38	1, 2, 4, 7
Y	GB 1283216 A	(COMPOFLEX) see page 1 line 71 to page 2 line 6, especially page 1 line 78 and page 2 line 1	1, 2, 7
Y	EP 0522380 A1	(HOECHST) see column 2 lines 37 to 49 and column 4 lines 6 and 7	1, 2, 7
Y	US 4791965 A	(WYNN) see column 2 lines 18 to 30 and 43 to 57, and column 3 lines 21 to 30, especially line 29	1, 2, 4, 7
Y	US 4144111 A	(SCHAERER) see column 2 lines 1 to 25 and column 3 lines 39 to 45	1, 2, 7

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